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The article discusses the history, role, and use of teaching machines and how they can be employed effectively in foreign language instruction. The selection of programed materials, prior study preparations, and the expected conditioned verbal responses arising from machine use are briefly discussed. The advantages of teaching machines are seen as greater language fluency, increased audiolingual skills, repetition without drudgery, convenience of use, facility of self pacing, and the possibility of teaching more languages at different levels on all grade levels. (DS)

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THE TEACHING MACHINE AND THE TEACHING OF LANGUAGES: A REPORT ON TOMORROW*

By F. Rand Morton

THE TITLE suggests a number of paradoxes. The concept of the "teaching machine" represents, on the one hand, one of the most revolutionary and challenging concepts facing teachers and educators today and, at the same time, looks back to one of the oldest basic psychological concepts of learning within the history of educational theory. Socrates' instruction of the slave boy in the *Meno* is perfect and persuasive illustration of the system of question-response basic to the efficacy of the modern teaching machine. Socrates, as we know, sought to persuade Meno that the slave boy's knowledge of a mathematical fact came not from teaching, but from questioning, and ultimately from recovery of innate knowledge.[1]

What Socrates did, however, in modern psychological terms was not to develop in the boy awareness of universal truths, but to teach the boy to deduce a mathematical formula by beginning from a common experience and working in small, logically sequenced, easy to take, minimal steps (represented by each question and answer); each answer is controlled by and built upon the preceding one and suggested by the question itself. Could the slave boy reconstruct his reasoning to arrive at the same formula the following week? Probably not—because he had only *responded* to the Socratic system, not learned the system itself. The modern Teaching Machine, in theory, is based on a science of the Socratic procedure; in practice it becomes a well defined technology for the exploitation of this procedure.

Perhaps the most curious paradox of all is that we have waited so long to make a science out of the art of past great teachers.[2] Indeed, one must wait almost twenty-one hundred years before first attempts (begun in the middle 1800's and which did not succeed)[3] were made to provide a machine which could ask students the correct questions in the correct order and thereby—in Socrates' words—"discover knowledge." But the modern Teaching Machine—in both its pedagogical concept and physical design—is entirely a product of our own century. (And if emphasis on chronology and perspective is noted here, it exists to correct a rather too general view that the modern teaching machine is but another diabolical invention of our most recent years: companion, some may feel, to the atomic bomb—and just as dangerous.) In 1910 a young psychologist, Sidney L. Pressey, at the University of Ohio began thinking about the design of the machine we are using today and in 1925 produced his first model. Since then literally hundreds of basically similar machines—some extremely simple, some highly complicated—have been developed and used experimentally. This

* An address delivered to teachers of modern and classical languages at the 73rd annual Schoolmaster's Club, Univ. of Michigan, Ann Arbor, 13 May 1960.

[1] I am indebted to Prof. John Barlow of Earlham College for reminding me of the appropriateness of the *Meno* here. The translation of relevant portions provided by W. K. C. Guthrie, *Plato, Protagoras and Meno* (Baltimore, 1956), pp. 136–138, was included as a supplement to his own paper "The Earlham College Student Self-Instructional Program," presented at the National Education Association Convention, Cincinnati, Ohio, March 1960.

[2] John Barlow, loc. cit.; B. F. Skinner, "The Science of Learning and the Art of Teaching," *Harvard Educ. Rev.*, XXIV (1954), 86–97; "Teaching Machines," *Science*, No. 128 (Oct. 1958), 969–977.

[3] James G. Holland, "Teaching Machines: An Application of Principles from the Laboratory," paper read at the Educational Testing Service Conference, New York City, Oct. 1959.

means that already a great amount of statistical and evaluative data are available for experimenters today. They—and we who follow them—need not work in a vacuum. Professor Pressey himself is "living proof" that his idea of half a century ago is no passing fad. At seventy-two he is still as actively and profitably engaged in the field as ever and remains one of its most distinguished, serious, and valuable contributors.[4]

In the 1930's, encouraged by his own success, Pressey predicted a coming "industrial revolution" in the field of education similar in many respects to that brought about through the mechanization of industry more than a hundred years before. That his prediction was not fulfilled then was due, perhaps primarily, to two basic facts: 1) at that time, high efficiency from educational systems was not considered of crucial importance, and it could not then be proved that machine teaching in any instance was superior to that of human, or live, teachers; 2) there was no real scarcity of human teachers. Neither of these two facts obtains today.

Some twenty years after Pressey's first experiments in the thirties, Professor B. F. Skinner of Harvard University began his own. Skinner was more fortunate than Pressey had been because, during the intervening years, a number of disciplines not immediately related to the field of mass education had made discoveries of tantamount importance to our knowledge of the learning process in both animals and humans. Where before primary interest had been given to the psychological processes of forgetting, now psychologists, neurologists, biological chemists had begun to explore the processes involved in the *acquisition* of knowledge. Utilizing this new information—to which he himself had contributed most significantly—Professor Skinner and his Harvard group began to devise a new kind of teaching "program" for the machine, designed to exploit the principles of learning which had been previously demonstrated in many small scale psychological laboratory experiments. The success Skinner and his group have had in recent years has renewed and broadened general interest in the concept of the teaching machine and has now created a semi-autonomous discipline in which many hundreds of teachers, researchers, and psychologists are working from all fields of the humanities and the sciences.[5] Teaching machine courses are now available for student use (from elementary to college level) in a large variety of subjects—including spelling, European history, arithmetic, elementary psychology, music appreciation, and (this fraught with symbolism) religion.

What are the comparative results—measured in student achievement—of machine courses and conventional, "live teacher," courses? In a majority of controlled experimental cases, where *identical* material has been presented by machine and live teacher, average final grades for machine students were superior to those for conventional students. Needless to say, many more tests must be made, and with each test many more questions will appear in need of answers. But contrary to our unconcern thirty years ago, today we must push energetically to find the answers, because now there are *not* enough teachers—and now, for the same reason, greater emphasis than ever is being placed on the real effectiveness of our educational systems. This does not mean that there are not—nor that there should not be—critics of and objections to the concept and implications of Teaching Machine instruction. But all sides of the story must be heard. Last year, for example, a very simple machine for teaching elementary arithmetic was placed (for experimental purposes) in a state institution for mentally handicapped children. After the usual psychometric testing (with the usual pitiful results), the experimenter began to show each child how to work (or play) with the machine. It soon became the most sought after object in the playroom, competing successfully with dolls, wagons, paint sets, and building blocks. Finally, there were so many altercations among the children in vying for the teaching machine that it was set in a special corner and the privilege of "playing" with it became a reward to the children who merited it for other unrelated work done in the institution. Before it was removed at the end of the experiment, many children, earlier considered hopeless, could add and subtract.

As is obvious, it is not the machine that teaches but the pedagogical materials put *into* the machine and presented to the student *by* the machine which actually do the teaching; just as it was not Socrates' voice but his questions which finally elicited the formula from the slave boy. These teaching materials are now commonly termed "programs." What *are* these programs

[4] S. L. Pressey, "Certain Major Psycho-Educational Issues Appearing in the Conference on Teaching Machines," in *Automatic Teaching: the state of the art*, ed. Eugene Galanter (New York, 1959), pp. 187–188.

[5] Edward B. Fry, G. L. Bryan, and J. W. Rigney, "Teaching Machines: an annotated bibliography," *Audio-Visual Communication Review*, VIII, Supplement 1 (1960).

and how do they work? They are composed, of course, by teachers and may take any one of many different forms. All of them assume and exploit essentially the same basic theories of the learning process. They may be described as follows:

1. The subject to be taught (in conventional terms the knowledge to be imparted) must be capable of verbal or graphic presentation, and it must be specified and pre-fixed. It may be either a very small, independent area of knowledge or performance (e.g., how to dismantle a rifle) or an extremely large and intra-related field of knowledge (e.g., a course in geographical anthropology). Once the "subject" is specified and prefixed, the program must next assume a certain set of intellectual abilities on the part of the student as well as a certain level (or amount) of relevant "pre-knowledge": this last might be either zero or an extremely high and sophisticated level.

2. The learning procedure to be used is "step-increment" learning. The program begins by presenting a single piece of information to the student, something perhaps already known, and related preferably to his own experience. Once the student has indicated he understands this initial piece of information, the machine presents him with a problem based on it. The problem may be in the form of a completion response statement in which the student fills in the blank, or a multiple choice question in which the student must select one answer from several. The question or problem is stated in such a way as to suggest (through any number of means) *what the right answer should be.* (A problem which the student cannot answer correctly on the first try is, by definition, a poor problem.) Next, the machine exposes to the student the correct answer or tells him that his choice of answers was right or wrong. Thus the student is immediately reinforced (that is, rewarded) by the knowledge that he has been right, or he is shown immediately that he was wrong. He then proceeds to the next question and follows the same procedure. Once he has completed a certain number of problems (generally termed a set) he begins again. Now, only the problems he failed to answer correctly on the first try are presented. He will continue until he has answered all correctly. In conventional terms, the student's final score is always "perfect."

3. Each step (problem and answer) presented by the program must be of a minimal nature, assuming no knowledge on the part of the student other than that gained in the preceding steps. If the logical or intellectual "jump" between two steps is too great for the student to make easily, the program is at fault, not the student. Some machines allow the student to set his own intellectual or logical pace, presenting ultra-minimal learning steps (or additional information) between the minimal steps themselves. A gifted student might skip these and thus proceed at twice the speed of a slower student.

4. Progress through the program must be controlled. No step can be left before the student learns the right answer; no set of steps can be left until the student has answered all correctly at least once.

It is easy to understand the advantages which such instruction has. The student, program, and machine work together, as a unit, without the need (for the moment) of a live instructor. As is well known, learning rates differ widely among students, and the machine will permit the individual student to proceed always and only at his own rate of speed. During his learning the student makes relatively few mistakes, and when he does he knows exactly what they are a moment after he has made them. Most important, the student is continually challenged (and thus motivated) not by the possibly antagonistic competition with another person but by his own capabilities. Above all, he is assured of final success. He knows that if he devotes enough time to the program he will emerge with the same achievement level as all of his classmates. Failure—in the usual sense—is by definition impossible. Failure to finish the program is alone possible, and this is entirely dependent on the time the student is willing to give to it. Certainly it is the most "democratic" form of teaching imaginable.

There are more advantages in machine teaching for the student than there is here time to list. Many more advantages result entirely for the teacher, and we shall see some of these, as they apply to the language teacher, later. But before turning to the subject of language teaching, it might be wise to dispel a dangerous misconception of the "*machine.*" The word itself is a poor one. Its infernal connotations seem to go completely against the humanistic grain. One might prefer (involuntarily) to think of it contemptibly as a "gadget"—or worse, as a highly complicated robot which one must spend long hours in learning to control and who may become overtly dangerous if his nuts or bolts or wires are loose.

Actually, the Teaching Machine is the most innocent a. d simple device imaginable. Some are no more than a cardboard box with two rollers and a plexi-glass window. Others are made of metal but only because they need to be more durable. None, presently in use, approach the complexity of a typewriter. Some may indeed resemble a small portable television set—which is an unhappy coincidence—but they contain no commercials. One of the simplest of these so-called "machines" is a punch card or "chemo-card" and several can take the form of an ordinary, conventional-size textbook.[6] Undoubtedly machines will appear in the future which will be far more complicated, internally, to make them better teachers. But externally they need never have more student controls than a portable phonograph. Rather than "Teaching Machine," one educator has suggested that the mechanical apparatus be thought of as a "self-tutoring device." In effect, the Teaching Machine *is* a mechanical tutor:[7] it works individually with the student, can indeed come into the student's home, guides him in his work, corrects him when he is wrong, prevents him from skipping important points, works almost intimately with him. For the teacher particularly, the implications of the term "tutor" are highly favorable. We cannot object if, according to our instructions, someone else helps prepare our students for us, saving us time and energy and permitting us to work with a group of students who have all had identical preparation in our subject. This would be a "good class"—and good classes are always exciting and pleasurable to teach.

In the beginning a paradox appeared—and several more have been seen as this discussion progressed. Yet another now appears when we attempt to relate the concept of the Teaching Machine with the field of language teaching. Man is still the only animal—or machine—that talks: how then can one expect that a non-talking thing might teach language? Even more contradictory seems the possibility of utilizing the conventional kind of teaching programs just seen for language teaching. In teaching psychology, chemistry, music appreciation, and even mathematics it was assumed that the students understood the language through which the minimal learning steps were presented. Certainly the ability to read a language fluently is presumed by all conventional programmers. At best then, the Teaching Machine as thus far conceived, could only tutor the student through a course in French, German, Latin, or Spanish *grammar*. It could teach him only the verbal formulations or applications of the *rules* a language follows. As language teachers we know only too well that the rules aren't language itself and that no matter how well a student memorizes linguistic prescriptions he may not be able, ever, to speak or understand a given language. Psychologists—and some educationalists—can subscribe to the contrary assumption (and have) but certainly not language teachers, who have so long insisted that language, to be successfully taught, must be taught on its first, oral-aural level. Our students must *use* the subjunctive "habitually" rather than to know *how* it is used. How can a machine teach them this?

To answer the question just posed, one must take another look at language—what language is, how it works. We will agree that everything man does is some sort of behavior. When man talks he is behaving, and we have ample proof that language is, essentially, verbal behavior.[8] Playing the piano is also behavior—now motor or digital behavior. The analogy of "speaking a language" with "playing a musical instrument" is valuable to us because the latter represents an experience that most of us have had at a considerably later date than our original experience with learning our own language. We may not remember how many times it took us to say "mama," imitating someone else, but we do remember only too well the difficulty we experienced in shaping the behavior of our muscular responses to play the scale of C minor. Our ordinary muscular behavior would not do. We had to work hard, practice the scale many, many times before we could form the muscular habit patterns necessary to play the scale quickly, evenly, forte and piano, staccato and legato, crescendo and diminuendo. Indeed, we had to change, modify, shape our previous digital and muscular behavior into a new kind of behavior to do it. We had to make new habits and we did this only through excruciating repetition. When we had finally achieved proficiency in the skill of playing the C minor scale (and all the others) we had simply conditioned our fingers to playing it *automatically* as the conditioned response to the

[6] Ibid., pp. 12–16.

[7] John Barlow, "Project Tutor," *Psychological Reports*, No. 6 (1960), 15–20; Finley Carpenter, "The Teaching Machine and Its Educational Significance," paper read at AACTE conference, Chicago, Feb. 1960.

[8] Wilse B. Webb, "The Psychology of Learning and Foreign Language Teaching," paper presented at a conference on language teaching at Wayne University, Detroit, Oct. 1958; B. F. Skinner, *Verbal Behavior* (New York, 1957); *Cumulative Record* (New York, 1960); Charles C. Fries, *The Structure of English* (Ann Arbor, 1954).

desire to play the scale or as the conditioned response to seeing the notes. We were not concerned with playing "music"; we were intent only in mastering the skill of manipulating our fingers and the piano keys in an arbitrarily set way. We called this arbitrarily set way "the scale of C minor." But this name meant very little or nothing to us—it really had no "meaningful" meaning except as another arbitrarily attached code name by which we could identify a certain mechanical, manipulative process or *behavior through which our fingers should move.* Later, when we met this same C minor scale, descending dramatically, tragically down through two octaves in a Beethoven sonata, it *did* become meaningful —musically meaningful. It was no longer a scale but an aesthetically significant musical experience. And we were no longer simply manipulating our fingers but utilizing our mechanical skill —our technique—to play, to make, *music.* The difference was simply that we had introduced "meaning" into the original structural pattern we had learned to execute. Much the same process occurred when we learned to speak. We practiced the acoustic pattern "mama" many times before we gave it meaning by using it in verbal communication—to create or make known something to someone else. More precisely we conditioned our lungs and vocal cords to go automatically through the necessary motions—to behave—when we wished to communicate with someone—when we wished to elicit a certain response from someone else. Thanks to the work of structural linguists we now know that speech, like music, is constructed out of set structural patterns, combinations of patterns, substitutions within patterns, occasional breaking of patterns into which meaning has been placed. We also know, in many cases, just which the most frequently used linguistic patterns are for a given language. These are the patterns we attempt to teach our students to manipulate quickly, automatically, "without thinking." Once they have this purely mechanical skill we want them to use it meaningfully—to "play" or "create" with it—that is, to express *themselves.*

A conclusion is obvious: before our students can learn to *use* a foreign language they must have the mechanical, manipulative skill necessary in handling its patterns. Do these patterns, while the student conditions his speech organs to produce them and conditions himself to respond *with* them at the appropriate stimuli, need to be meaningful? Probably not. What is important is that the *physical ability to perform this verbal behavior—the skill—be learned.* Can the machine do this part of the teaching job for us? I believe it can do it better than the teacher himself. To shape old behavior one must move in the direction of the new behavior always in very small steps; and to make this new behavior a habit one must repeat it many times; and to respond with this new behavior to an appropriate stimulus one must practice this response until it is a conditioned one. This is how we "learn" new behavior. When two persons meet on the street and one says "Good morning," the other "answers" "Good morning" because this is a conditioned response. The meaning is not really "I hope you have a good morning" but simply "I recognize your presence in front of me." When one furrows his brow, pokes himself in the stomach and says "Me?" another automatically says, "Yes, you." Again we are dealing with a conditioned response. The meaning is something else: "Do you mean it?" "Yes, I do." Imagine now that all our foreign language students could respond so naturally, so quickly, so "conditionedly" to all of the possible verbal stimuli of this kind that one might utter to him in the foreign language, even though he does not know "just what they mean." Would this not be as important (and necessary) an accomplishment as playing the C minor scale perfectly? I believe it would.

How many conditioned responses are there in any given language? How many arbitrary patterns which the student must first be able to manipulate and later condition their production to certain pre-set (arbitrary) verbal stimuli? I submit that almost all that is normally presented as grammar—as structure—falls into this category. Speaking generally, one might say that everything but vocabulary—lexical meaning —falls into this category. The conjugation of verbs, the use of pronouns, the placement of prepositions, adjectives, adverbs, the use of interrogative words, idioms, of course, these all act as structural, verbal stimuli or responses whose automatic, arbitrary relationship is behavior: conditioned verbal behavior.

If one learns new behavioral patterns through repetition, we must teach it the same way. Faced with twenty students in a class we, as language teachers, simply do not have the time to give each student a sufficient number of verbal stimuli to condition an arbitrary response. (Hundreds of repetitions are necessary to shape and make habit the necessary verbal behavior.) Nor should we. Why should we, when a machine—a private mechanical tutor—can do it? Indeed, only the machine can fully exploit the potential of minimal step-increment learning. We would never

have the patience—because we are humans—to ask a student "Me?" a hundred times, to hear "Yes, you" a hundred times and then yet another hundred times repeat, reinforcing his response by telling him he is right, "Yes, you." But the machine enjoys doing this kind of thing. It never becomes bored, or hoarse—or impatient. And the student, thanks to the machine, can choose his own speed of work, stop when tired, begin again (after the inspiration of a candy bar), work as long as he wishes in the knowledge that he is forming necessary habits and not merely seeming stupid in his teacher's weary eye.

Are there Language Teaching Machines available? Not at the moment—but there are language labs which can do much the same[9]—and the individual machines are coming.[10]

As has the final paradox: What will be the results of the teaching machine when used in language teaching? For the student it will mean that he cannot fail—it will mean that he can be guaranteed that he will speak a language if he is only willing to work. It will mean that in working with a machine, he himself will become half the teacher.

For the national language program we can predict an even more startling result. It will make no language too exotic to be taught and it will allow us to teach many languages, and many different levels of languages, on all grade levels. Language instruction can be carried out in private homes and the adult student—discriminated against so long with regard to adequate foreign language instruction—will find, finally, that it is possible to learn—and use—a new language without going back to language laboratory equipped colleges.

And the happiest paradox of all is for the language teacher. We may finally cease to pretend we are machines and begin to exploit ourselves as humans. Our students and their mechanical tutors will do their necessary drill work out of our sight—and hearing. When they come to us they will be prepared—always well and each week more fully—to begin to *use* their language skills in natural communication with us. Our pleasant responsibility will be to teach them to use with art the skills which they have mastered through science. We who speak the language and know its culture can teach them its human values. And if this is our true profession we ourselves can never be replaced by any machine, unless we change our definition of language as human communication. For let us acknowledge, finally, what our function as "language teachers" really is. One learns a new language only because it is or was spoken by another people, another country, another civilization, different, in some way, from one's own. One learns the new language, hopefully, to communicate with this other country, distant in some way, from one's own. We, as language teachers, are in our own country the representatives of these different and distant countries and their people. Those who cannot go "abroad" to them must come to us. To talk and learn. We, as human language teachers, will be "necessary" as long as there are different countries, different peoples, who need *us* to represent *them* in a "foreign" land. *Our* great responsibility as human teachers is to be worthy representatives of the human values we teach.

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[9] F. Rand Morton, *The Language Laboratory as a Teaching Machine* (Ann Arbor, 1960): Publications of the Language Laboratory, Series Pre-prints and Reprints, Bureau of School Services, Univ. of Michigan.

[10] John B. Carroll, "Initial Specifications for an Audio-Visual Automated Teaching Device," compiled under a grant from the Society for the Investigation of Human Ecology, Forest Hills, New York. Hamilton Research Associates, New Hartford, New York, have already devoted considerable engineering time to a machine adaptable to the automatic teaching of oral-aural language skills. Most recently the Mott Foundation of Flint, Michigan, has indicated its interest in researching a portable language teaching machine for use in adult education language classes sponsored by the Foundation.